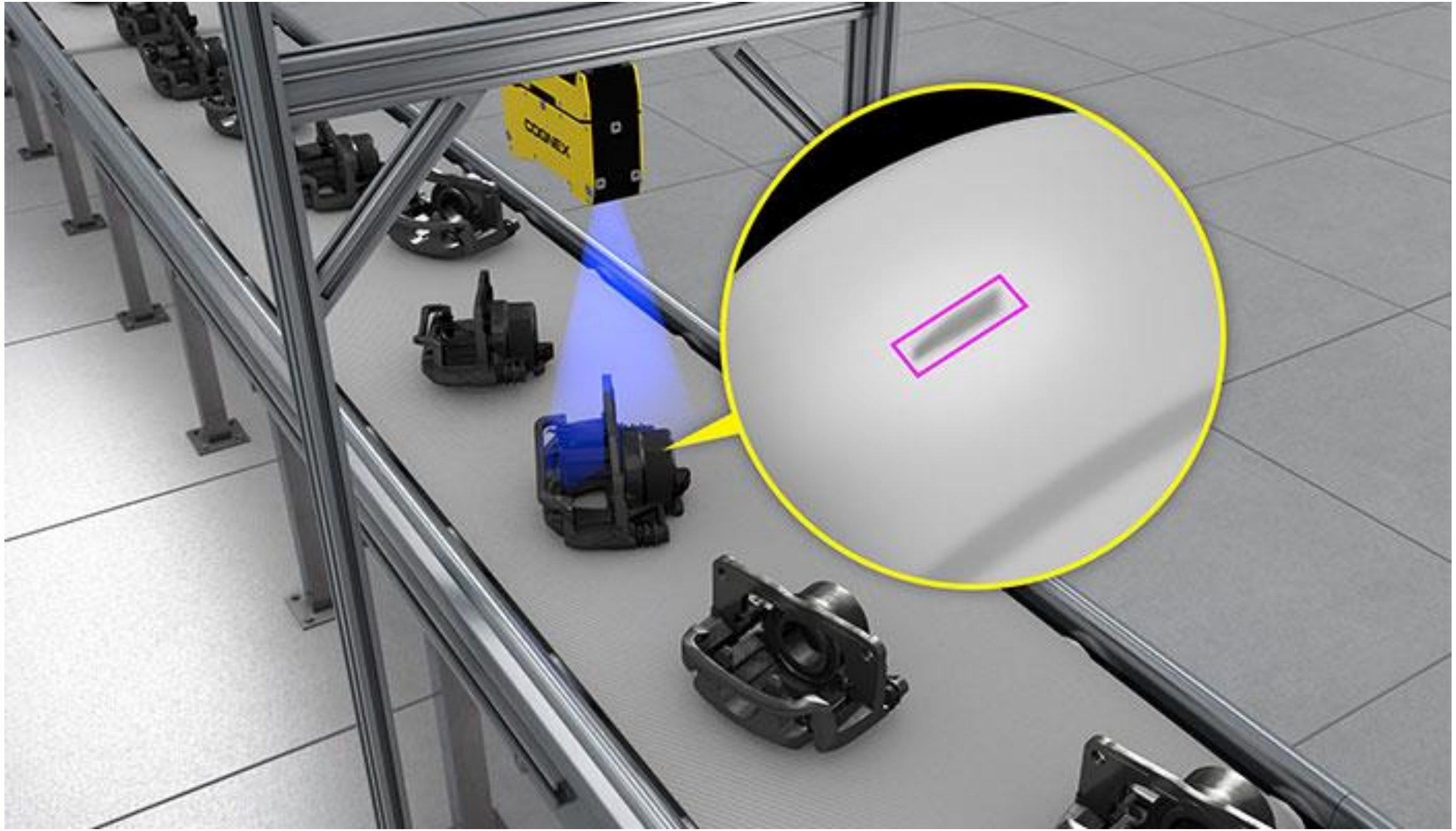
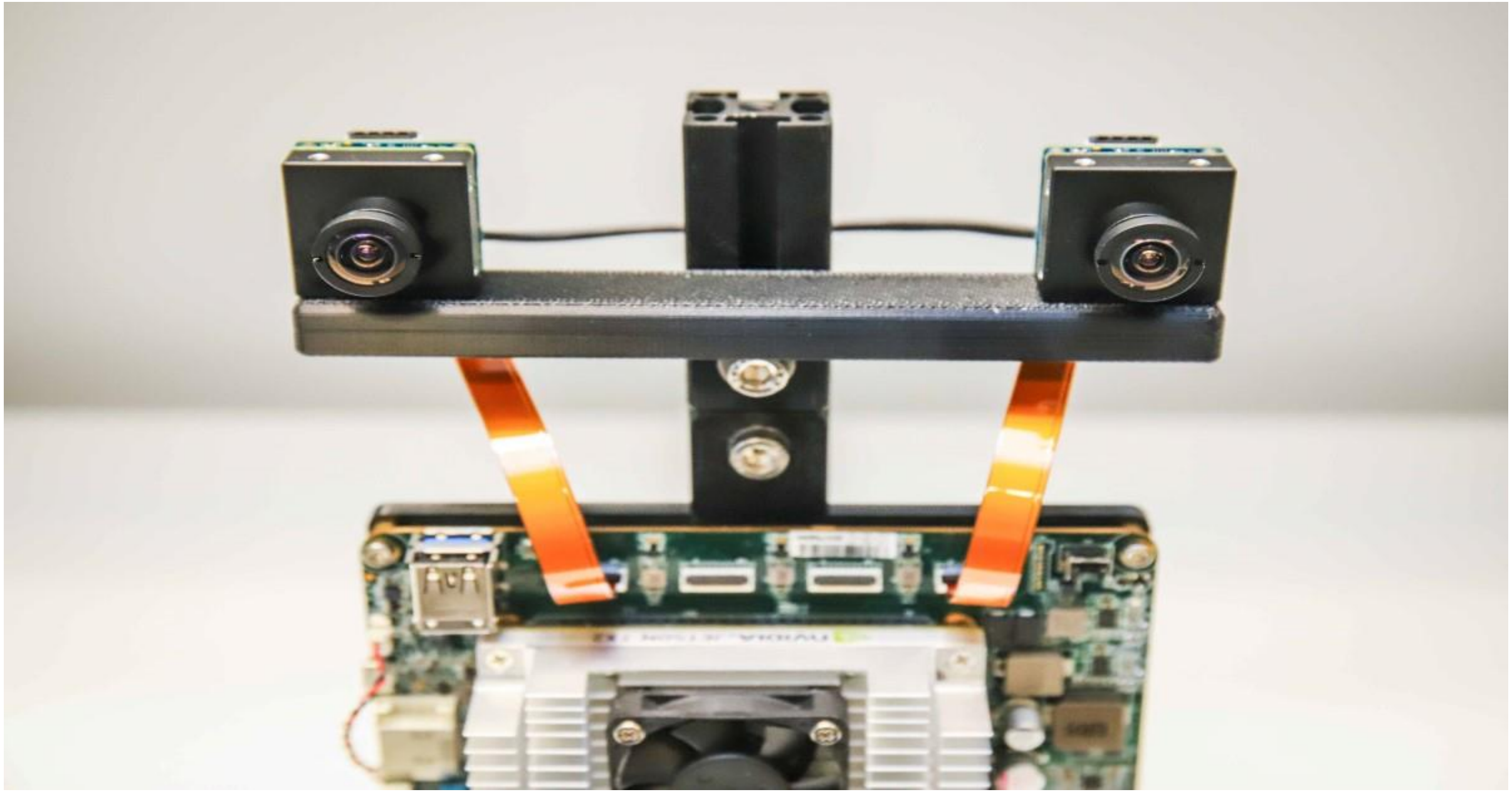
Machine Vision in Action

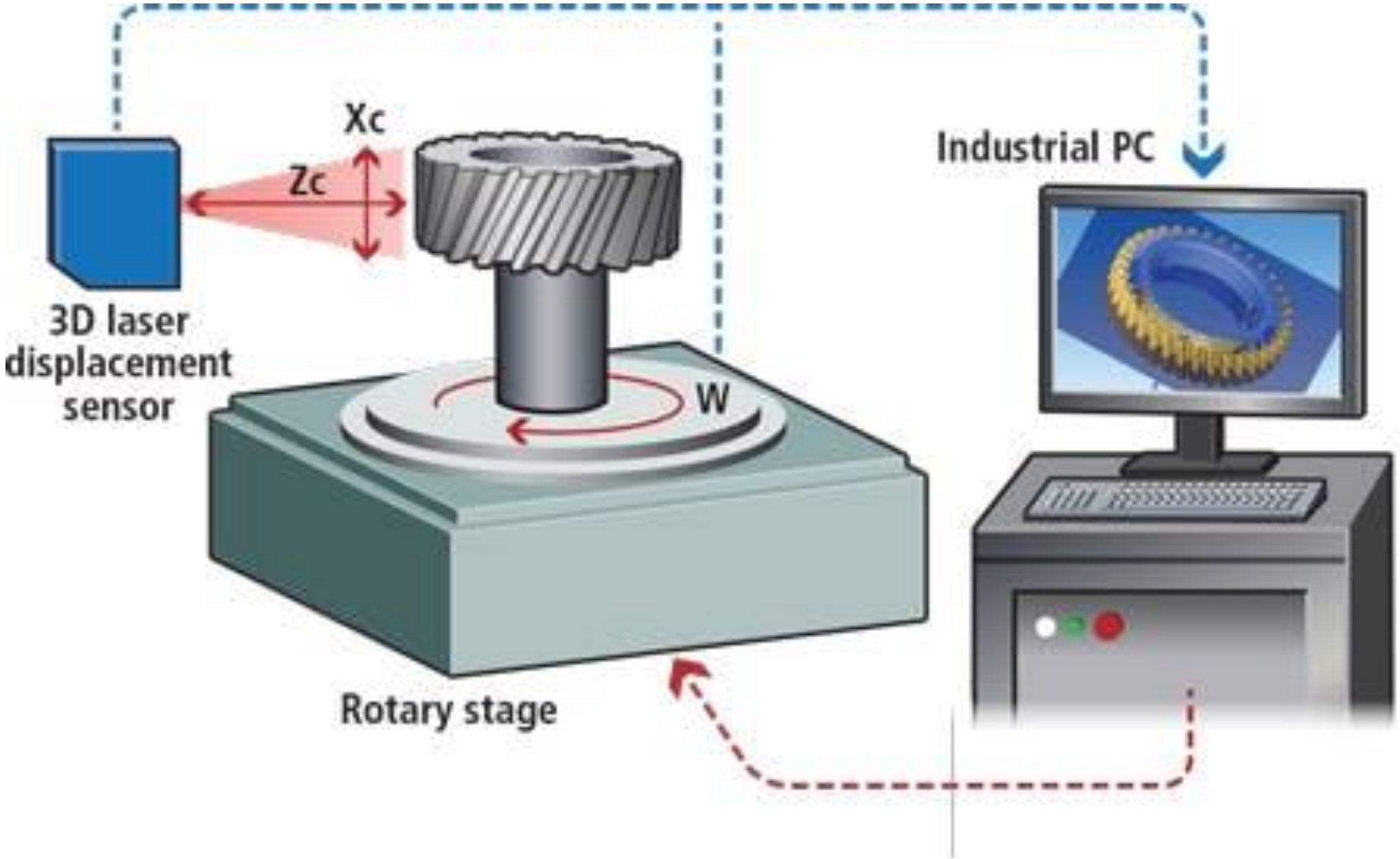
Session-15

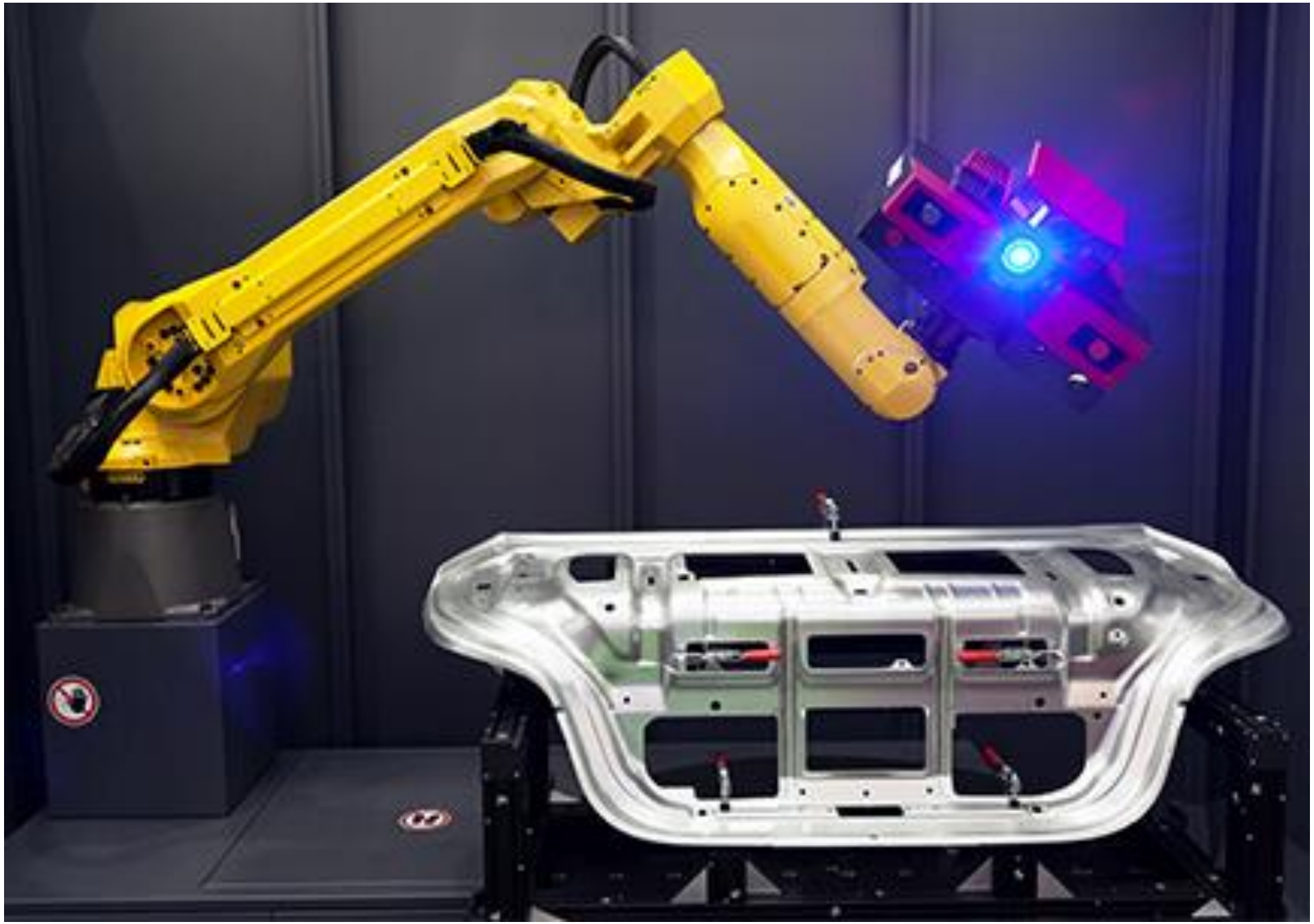
Problem Statement

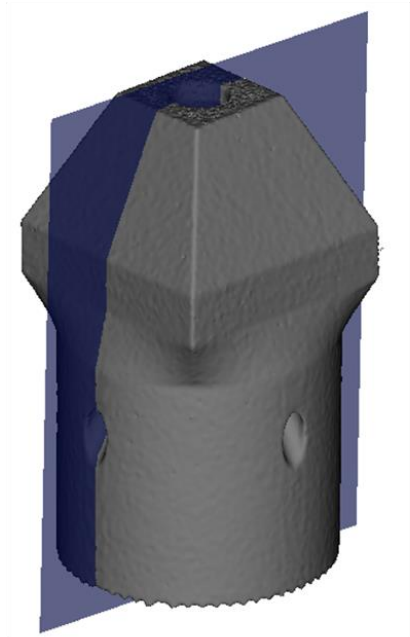
In high-throughput industrial manufacturing settings—such as automotive assembly lines, aerospace part production, and electronics fabrication—ensuring the structural integrity and surface quality of components is critical. Traditional manual inspection methods are no longer sufficient due to their limitations in speed, accuracy, and repeatability. There is a growing need for intelligent, automated systems that can reliably identify defects with minimal human intervention, even in challenging lighting and environmental conditions.

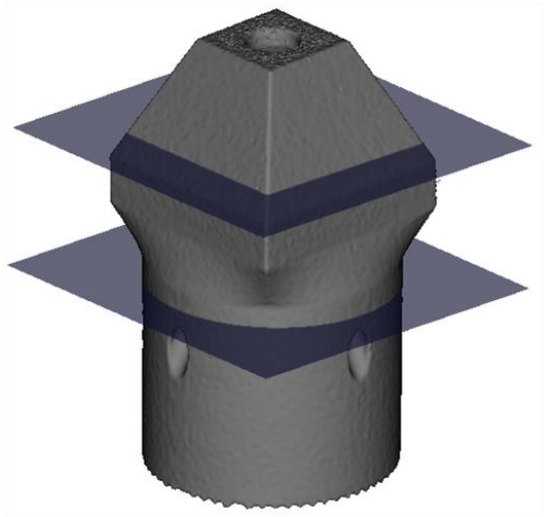


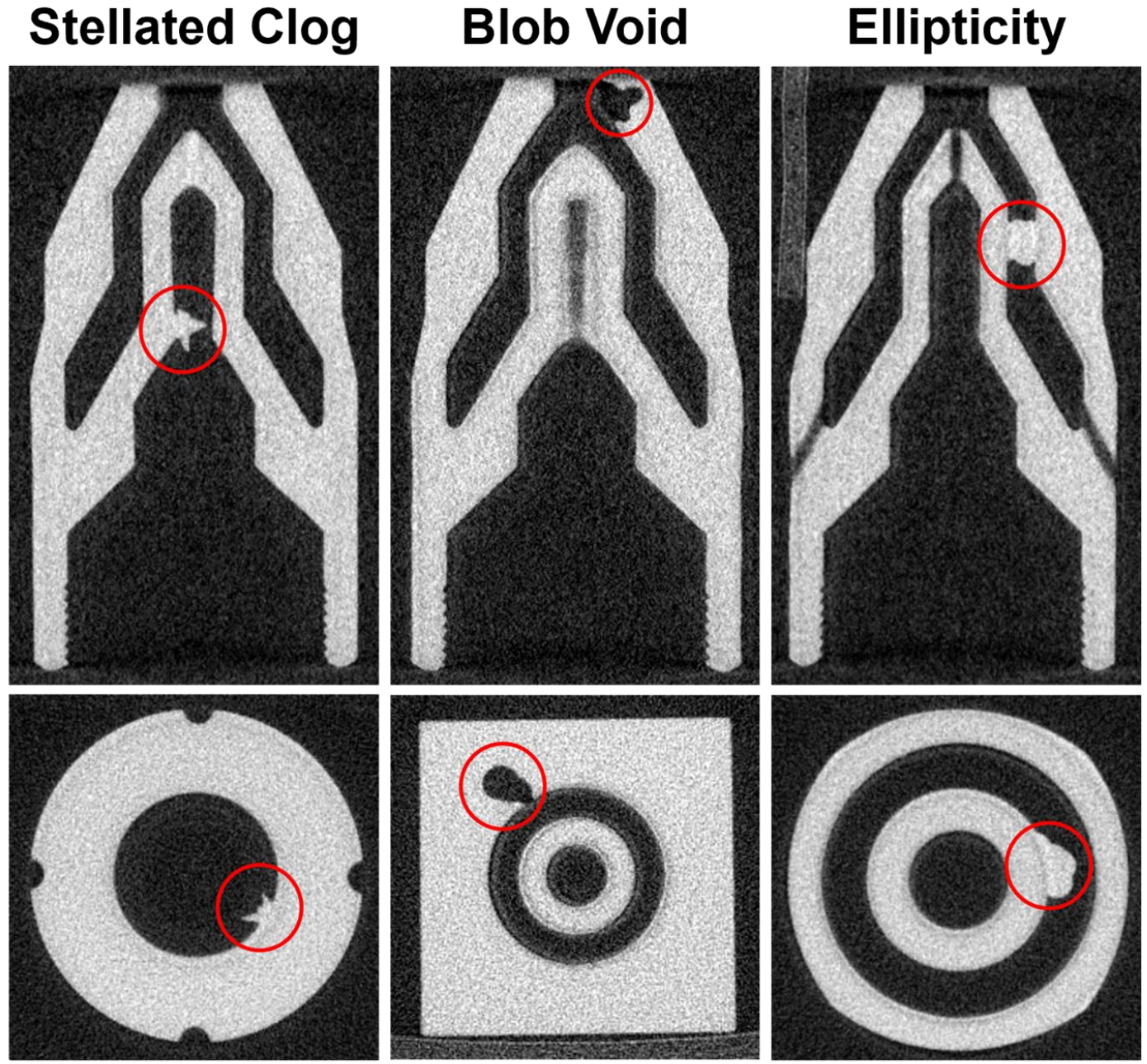



Xc
Zc
3D laser
displacement
sensor
W
Rotary stage
Industrial PC








Stellated Clog
Blob Void
Ellipticity

Objective

Develop and deploy an automated machine vision system capable of detecting, localizing, and classifying surface and structural defects on manufactured components using advanced image processing and 3D vision techniques.

Expected Outcomes

Reduction in false positives and missed defects.

Increase in production efficiency and product quality.

Lower cost of rework, returns, and warranty claims.

Application Areas

Automotive engine and body part inspection

Aerospace turbine blade and fuselage component analysis

Electronics PCB and solder joint verification

Quality assurance in additive manufacturing (3D printed parts)

Technical Requirements

3D and Stereo Vision Integration

- Implement stereo camera systems or structured light scanning to generate accurate 3D models or depth maps of components.
- Enable volumetric analysis to detect surface deformations, dimensional deviations, and subsurface anomalies.

Robust Image Segmentation

- Perform segmentation to separate components from complex backgrounds and isolate regions of interest, such as edges, weld joints, or mounting points.
- Adapt to variable shapes, finishes (matte, glossy), and textures of parts.

Technical Requirements

Thresholding and Filtering

- Apply adaptive thresholding and advanced noise-reduction filters to prepare images for defect detection.
- Account for ambient light variation and sensor noise in harsh factory environments.

Image Enhancement

- Enhance image clarity using techniques like contrast adjustment, edge sharpening, and reflection suppression to improve visibility of micro-defects and fine textures.

Feature Extraction and Pattern Recognition

- Extract geometric, texture, and topological features from 2D and 3D image data.
- Use machine learning or rule-based pattern recognition to classify defects (e.g., cracks, dents, warping, misalignments) and flag critical issues based on severity.

Technical Requirements

Real-Time Performance and Scalability

- Ensure processing throughput matches or exceeds the pace of the production line.
- Design for scalability and modular integration with existing MES/SCADA systems.

User Interface and Reporting

- Provide an intuitive dashboard for operators to review results, override classifications, and generate quality reports.
- Include fail-safe alerts and logging for traceability and compliance audits.

Systems in the Market

- **Qualitas Technologies – Machine Vision in Defect Detection Activities**
  This resource showcases industrial applications of AI and 3D imaging for defect detection, including visual inspection systems and machine setups.
  View Images

- **Cognex – 3D Machine Vision Systems**
  Cognex provides examples of 3D vision systems used in industrial settings, illustrating how depth sensing and surface inspection are performed.
  Explore Systems

Systems in the Market

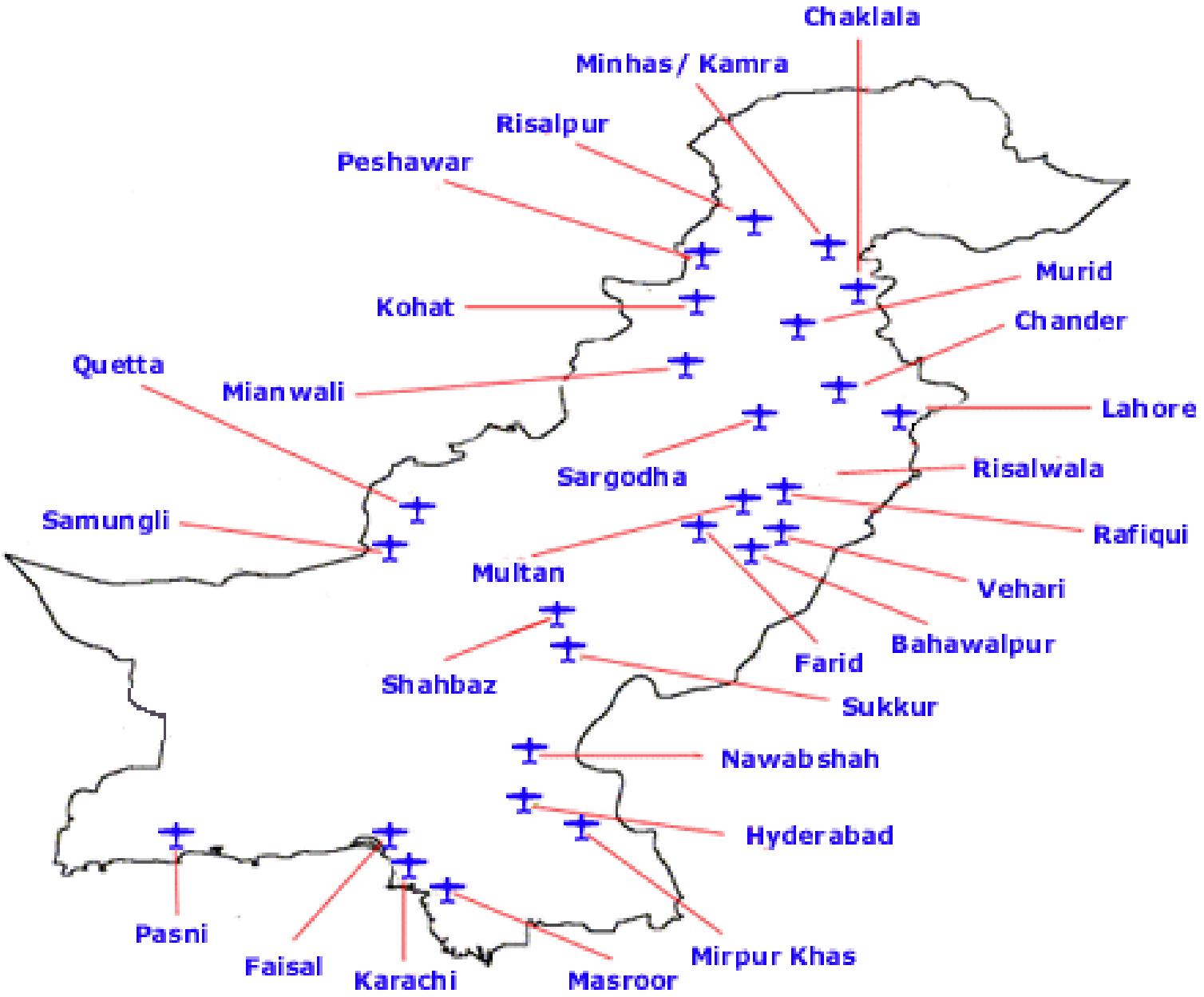
- **Teledyne Vision Solutions – Building a Custom Embedded Stereo System**
  This guide includes images of stereo vision setups for depth perception, useful for understanding hardware configurations in industrial environments.
  Learn More

- **Euresys – Photometric Stereo for 3D Surface Inspection**
  Euresys demonstrates the use of photometric stereo techniques for detailed 3D surface inspection, highlighting image processing workflows.
  View Details

- **Zivid – 3D Stereo Vision**
  Zivid offers insights into 3D stereo vision technology, with images depicting how their systems capture and process depth information.
  Discover Technology

Problem Statement

Military bases and critical infrastructure require continuous, automated monitoring to detect and classify potential threats such as unauthorized drones, vehicles, or intruders. Traditional surveillance systems lack the ability to accurately interpret complex scenes, especially under low visibility or cluttered conditions.


Chaklala
Minhas / Kamra
Risalpur
Peshawar
Murid
Kohat
Chander
Quetta
Mianwali
Lahore
Sargodha
Risalwala
Samungli
Rafiqui
Multan
Vehari
Bahawalpur
Farid
Shahbaz
Sukkur
Nawabshah
Hyderabad
Pasni
Faisal
Karachi
Masroor
Mirpur Khas

Challenges & Objectives

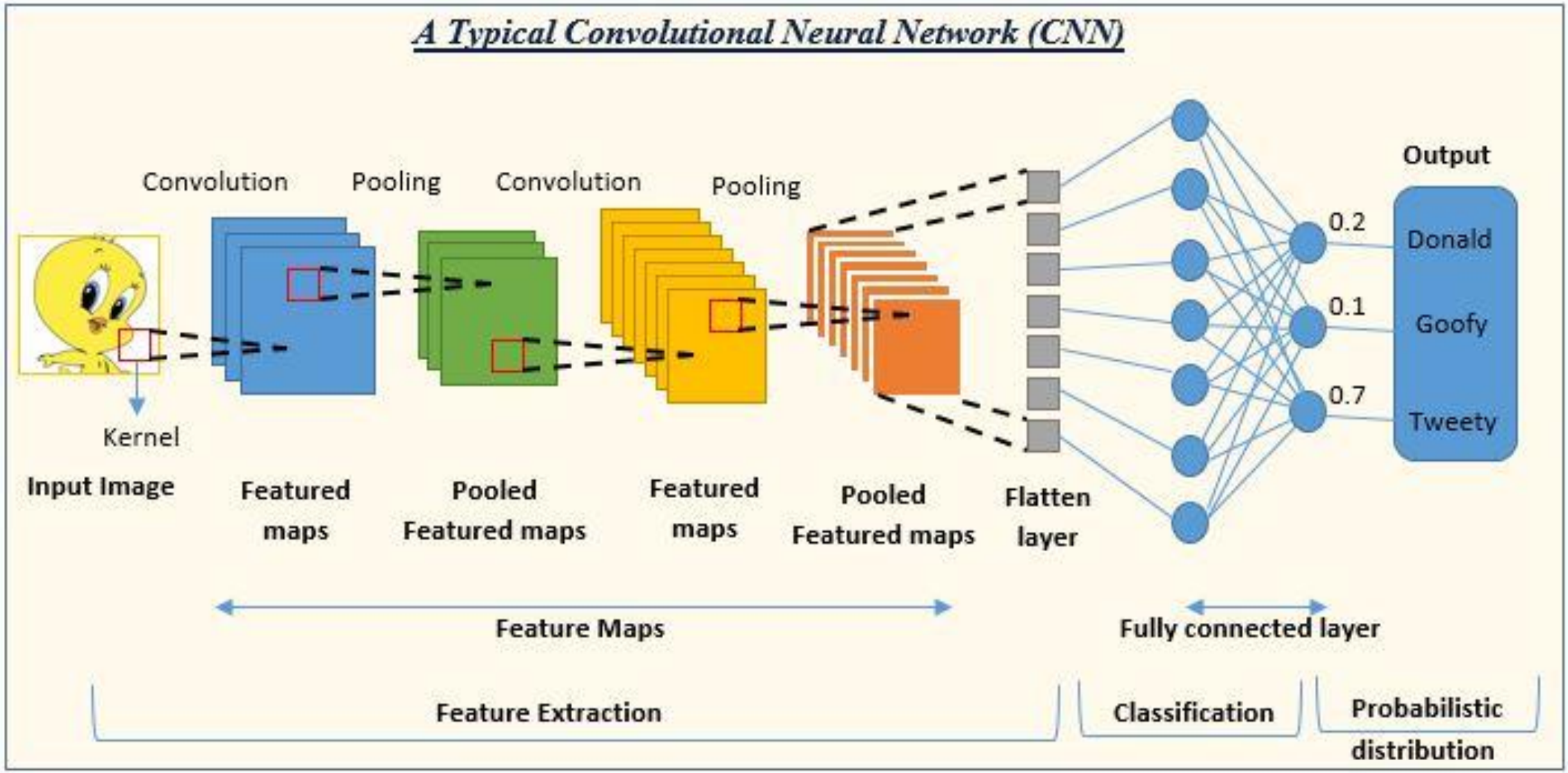
Design a machine vision system for real-time threat detection and classification using stereo vision and multi-spectral image processing. The system should:

Segment dynamic scenes and extract relevant patterns (e.g., shapes, movement, thermal signatures).

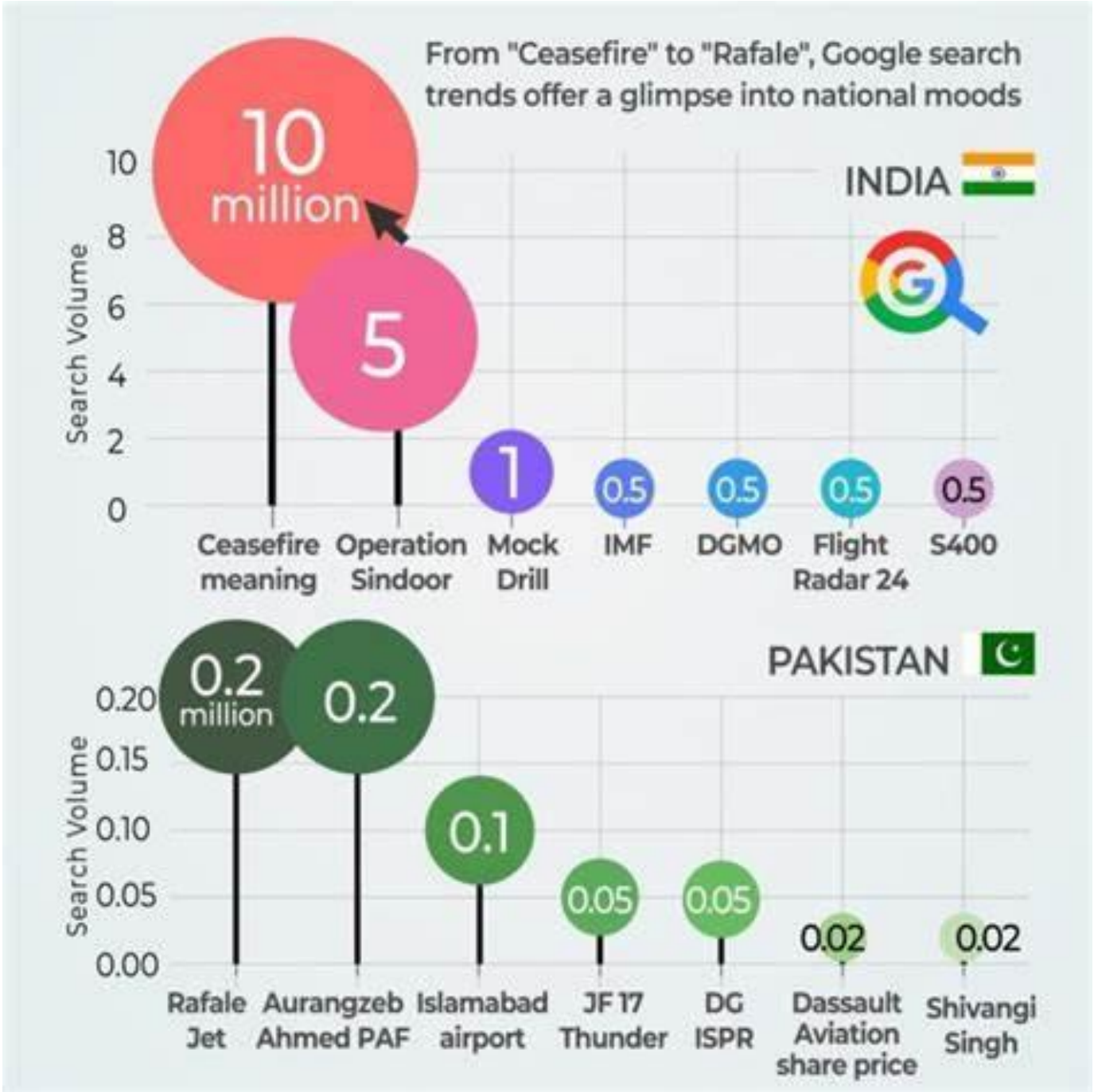
Use filtering and image enhancement techniques to handle challenging environments like fog, night-time, or camouflage.

Employ 3D object reconstruction to distinguish between benign and suspicious objects.

Integrate machine learning for pattern recognition and behavior analysis to prioritize alerts and minimize false positives.


A Typical Convolutional Neural Network (CNN)
Convolution
Pooling
Convolution
Pooling
Output
0.2
0.1
0.7
Donald
Goofy
Tweety
Kernel
Input Image
Featured maps
Pooled Featured maps
Featured maps
Pooled Featured maps
Flatten layer
Feature Maps
Fully connected layer
Feature Extraction
Classification
Probabilistic distribution

AVM Aurangzeb Ahmed was one of the most searched individuals in Pakistan, with 2.02 mln searches on Google.


From "Ceasefire" to "Rafale", Google search trends offer a glimpse into national moods
INDIA
Search Volume
10
8
6
4
2
0
10 million
5
1
0.5
0.5
0.5
0.5
Ceasefire meaning
Operation Sindoor
Mock Drill
IMF
DGMO
Flight Radar 24
S400
PAKISTAN
Search Volume
0.20
0.15
0.10
0.05
0.00
0.2 million
0.2
0.1
0.05
0.05
0.02
0.02
Rafale Jet
Aurangzeb Ahmed PAF
Islamabad airport
JF 17 Thunder
DG ISPR
Dassault Aviation share price
Shivangi Singh